Wetland Restoration as a Climate Change Mitigation Strategy for Water Sustainability in the Kankakee River Watershed

a.k.a. Kankakee Project

Changes in Hydrology & Recreational Value

UPPER MIDWEST & GREAT LAKES LANDSCAPE CONSERVATION COOPERATIVE

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Project Team:













Alan F. Hamlet, Surface Water Hydrologist, University of Notre Dame
Chun-Mei Chiu, Post Doc. Hydrologist, University of Notre Dame
Diogo Bolster, Groundwater Hydrologist, University of Notre Dame
Zachary Hanson, PhD. Student Hydrologist, University of Notre Dame
Kyuhyun Byun, Post Doc. Hydrologist, University of Notre Dame
David Lampe, USGS Kentucky-Indiana Water Science Center
Jason McLachlan, Paleobotanist, University of Notre Dame
Jody Peters, PalEON project manager, University of Notre Dame
Mark Schurr, Archeologist, Department of Anthropology, University of Notre Dame
Ralph Grundel, Ornithologist/Ecologist, U.S. Geological Survey, Great Lakes Science Center
Noel Pavlovic, Botanist/Ecologist, U.S. Geological Survey, Great Lakes Science Center
Jessica Hellmann, Climate Change Ecologist, University of Minnesota
Tammy Patterson (ME!), Conservation Ecologist, U.S. Geological Survey, Great Lakes Science Center

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Upper Midwest & Great Lakes Landscape Conservation Cooperative ,

U.S. Geological Survey-Great Lakes Science Center,

University of Notre Dame

RFP: Identify and integrate objectives for waterfowl habitat, waterfowl populations, and people.

Projects should develop and apply a modeling framework to link waterfowl population objectives, habitat objectives, and the values of stakeholders.

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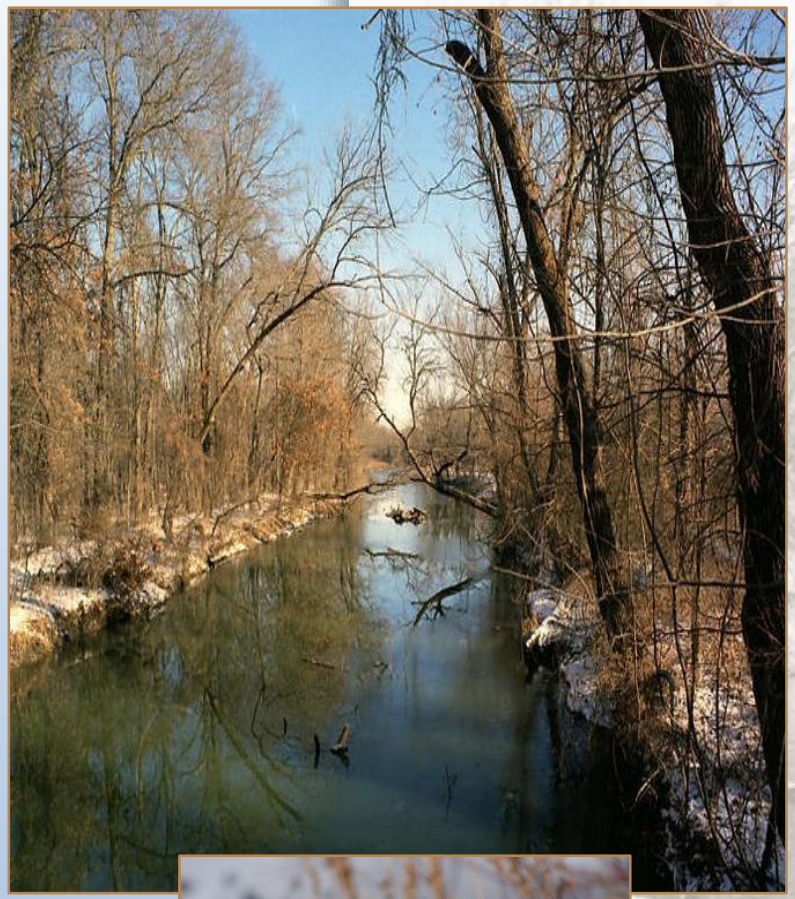
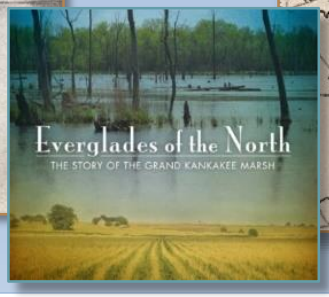
Project Goals:

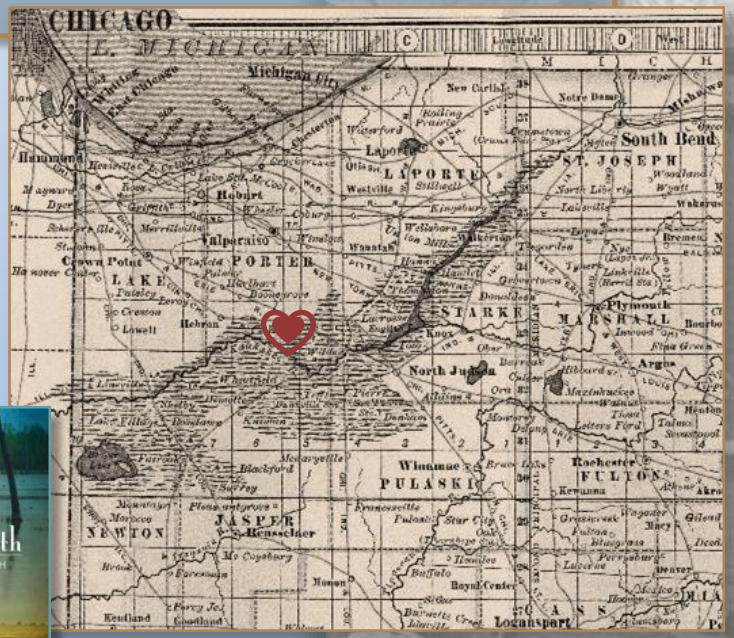
- Build surface & groundwater models
  - surface water storage
  - groundwater recharge
  - aquifer storage & use
- Couple to ecosystems service models
  - waterfowl production/habitat
  - waterfowl hunter value
  - recreational user value
  - agricultural production
- Identify wetland restoration scenarios
  - improved historic knowledge
  - peer-input
- Assess scenarios
  - at present
  - under climate change projections
- Inform watershed planning efforts to create a resilient, sustainable future!



Why Kankakee River?

- Once home to Grand Kankakee Marsh
- Hydrology is highly modified system
- Predominantly agricultural landscape
- Some quality remnant wetlands remain
- Wetland restorations completed in watershed
- Potential for National Wildlife Refuge





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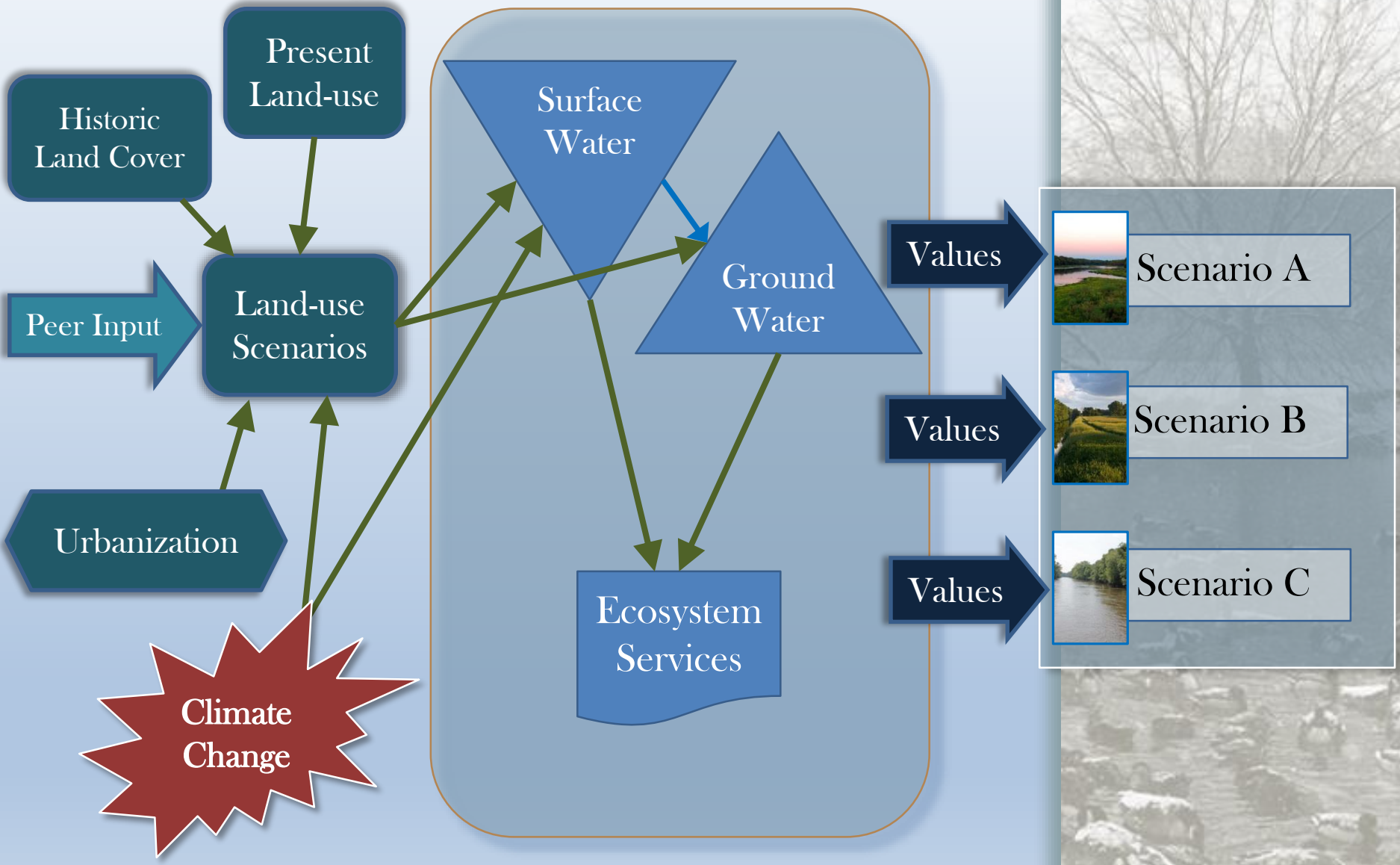
Modeling Scheme



Hydrology Modeling Methods

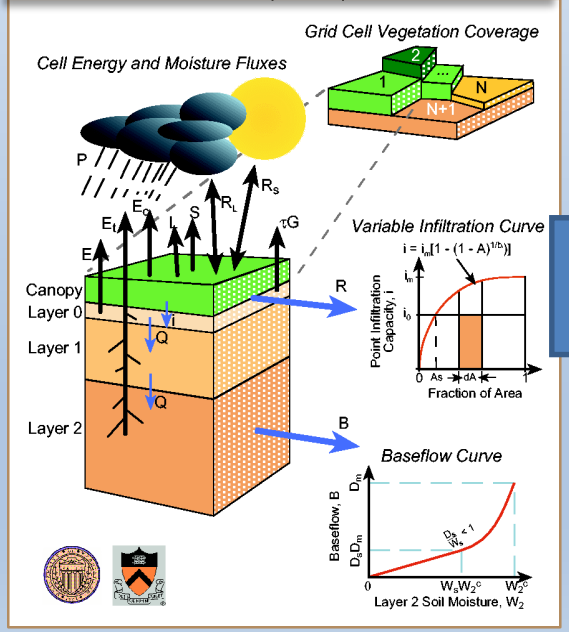
Surface Water Model--Variable Infiltration Capacity (VIC)

- Value for surface water storage & recharge to groundwater

Ground Water Model--MODFLOW

- Water table heights
- Groundwater storage

Variable Infiltration Capacity Hydrologic Model

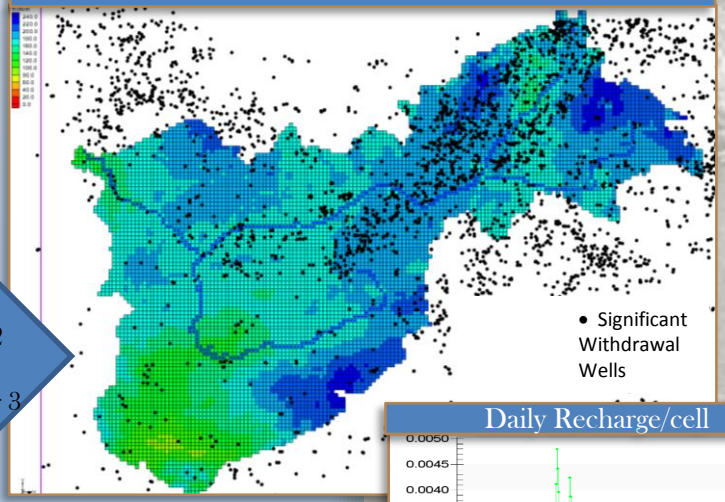


Recharge = $Q_2 - ET_2$

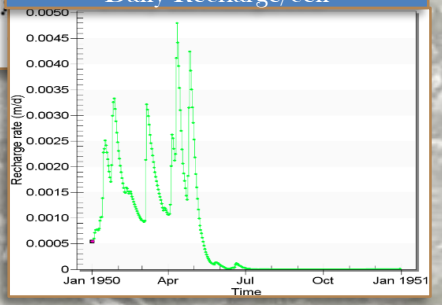
Q3 = flow into layer 2

ET2 = evapotranspiration from layer 3

MODFLOW Groundwater Hydrologic Model



Daily Recharge/cell



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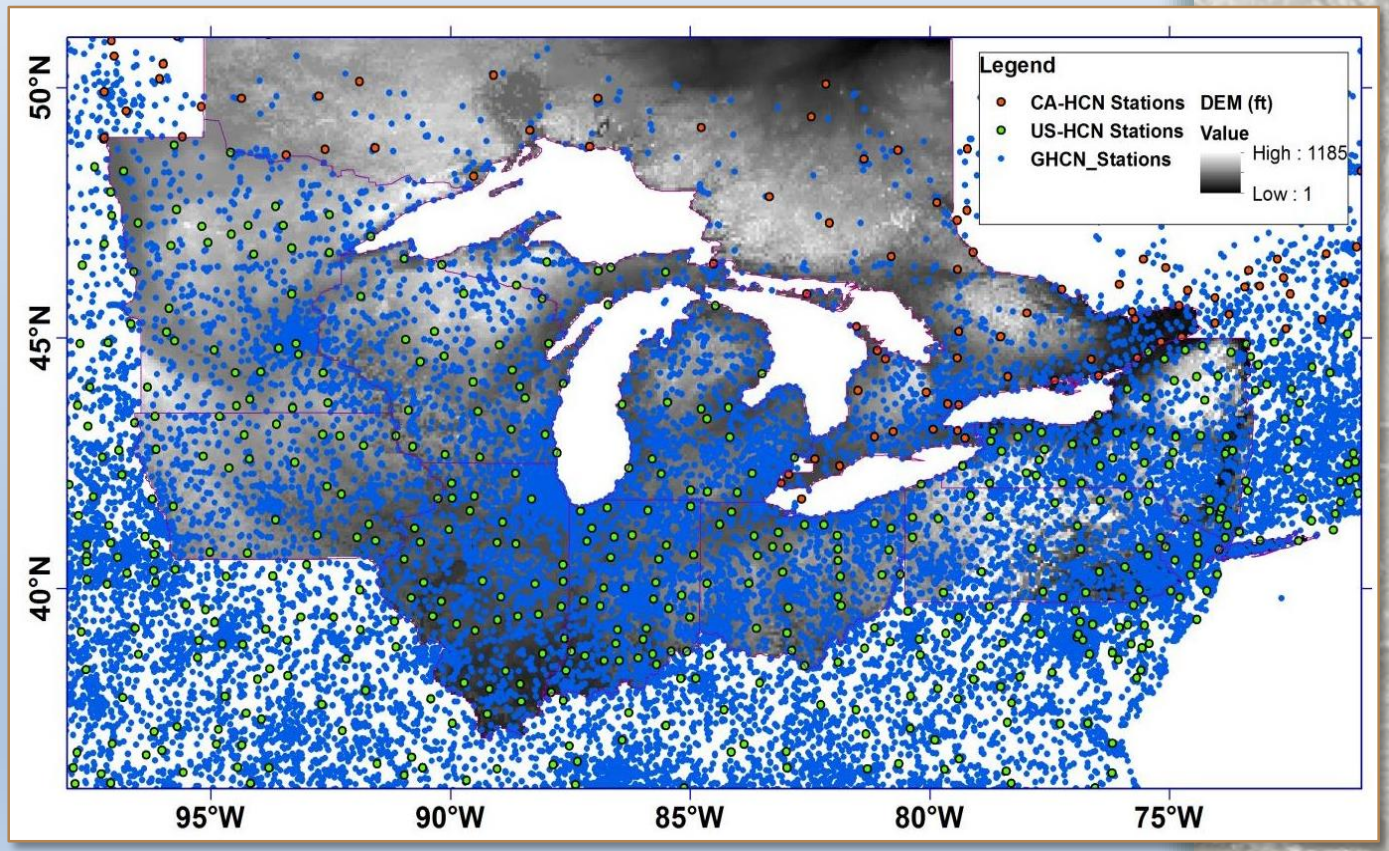
VIC Surface Water Meteorological Driving Data

- Interpolate weather data from Co-oP, HCN, and PRISM
- Timescale: 1915-present
- Area of interest: Great Lakes states

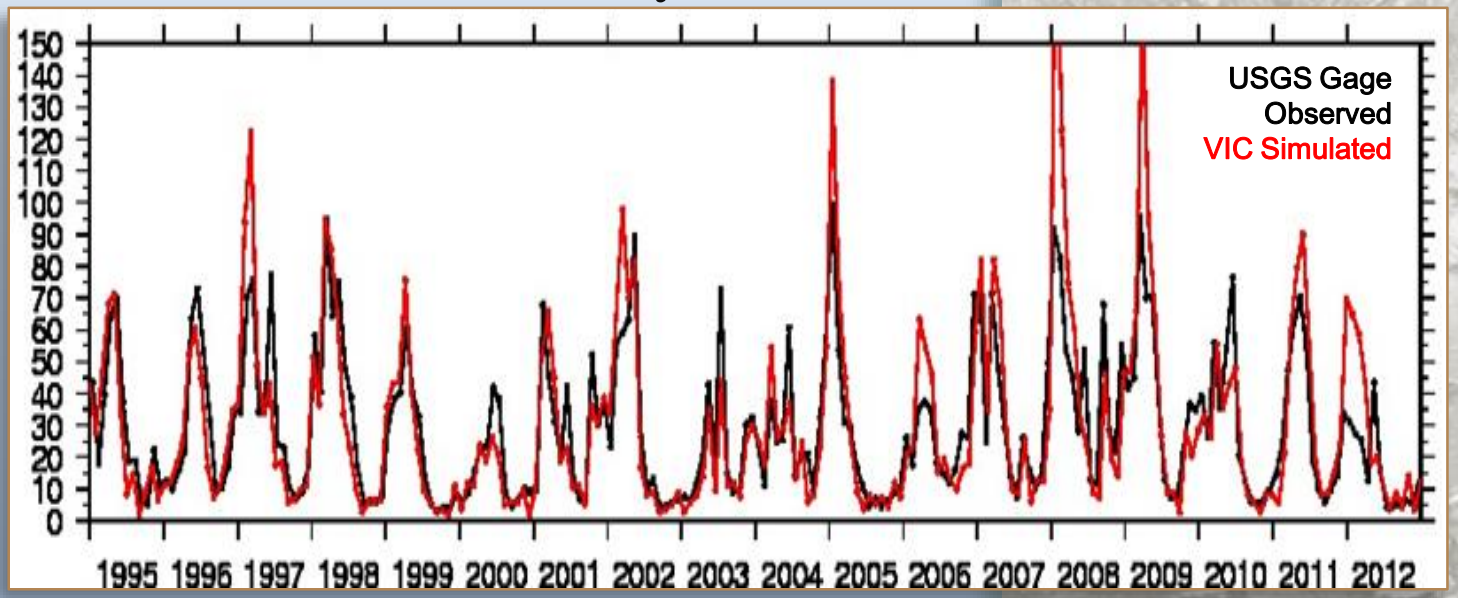


Chiu, C.-M., A.F. Hamlet, Macro-scale precipitation gauge undercatch corrections for the Midwest and Great Lakes region, 2016, J. of hydrometeorology (In processed) http://www.crc.nd.edu/~cchiu2/DownloadSite.html

Surface Water Balance

- VIC model corrected for spatial variability, precipitation undercatch, & height of wind velocity measurements
- $R^2 = 0.892$ NSE = 0.730 Ration of means (sim/obs) = 0.862

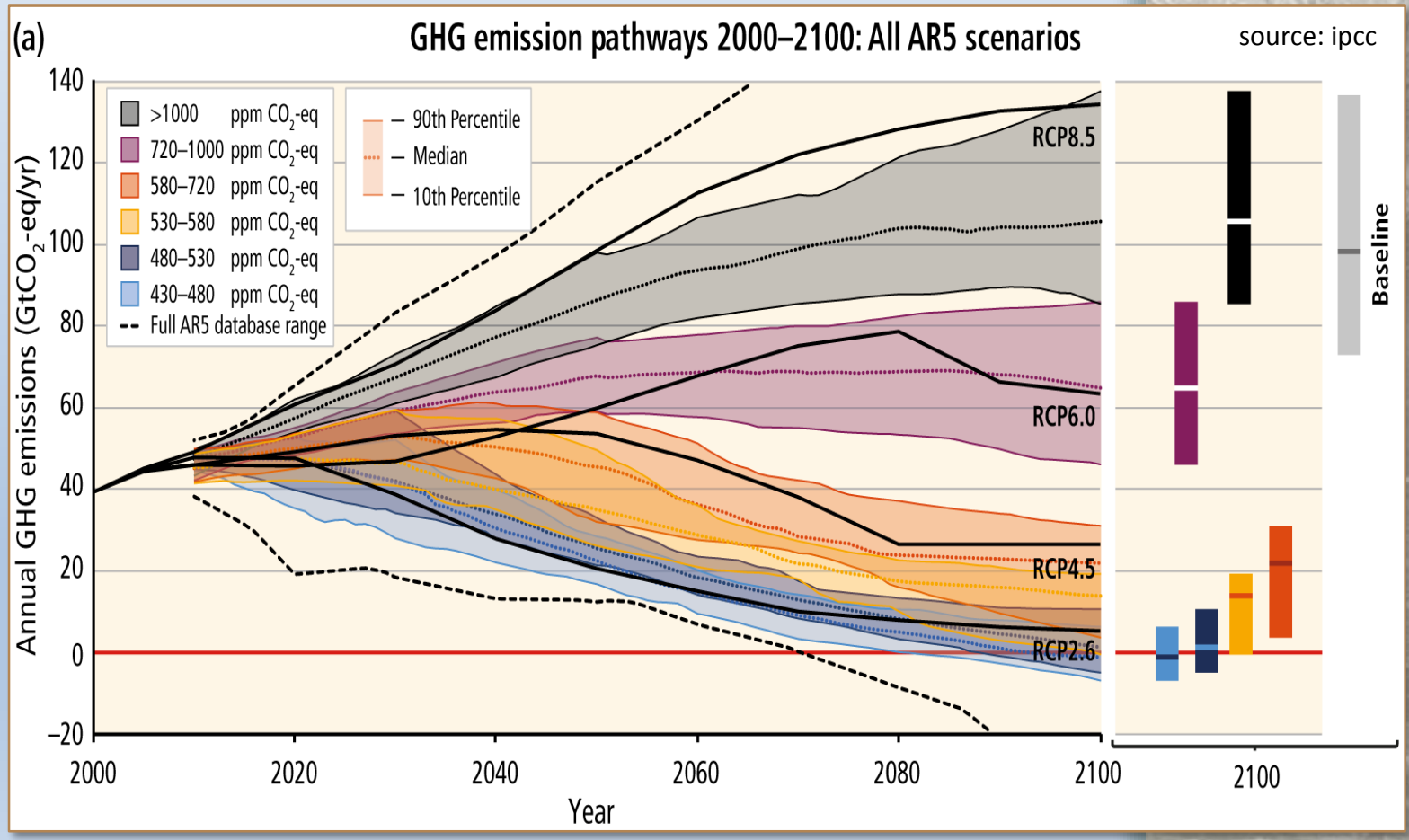
Monthly Streamflow



Climate Change Emissions:

Clmate Change

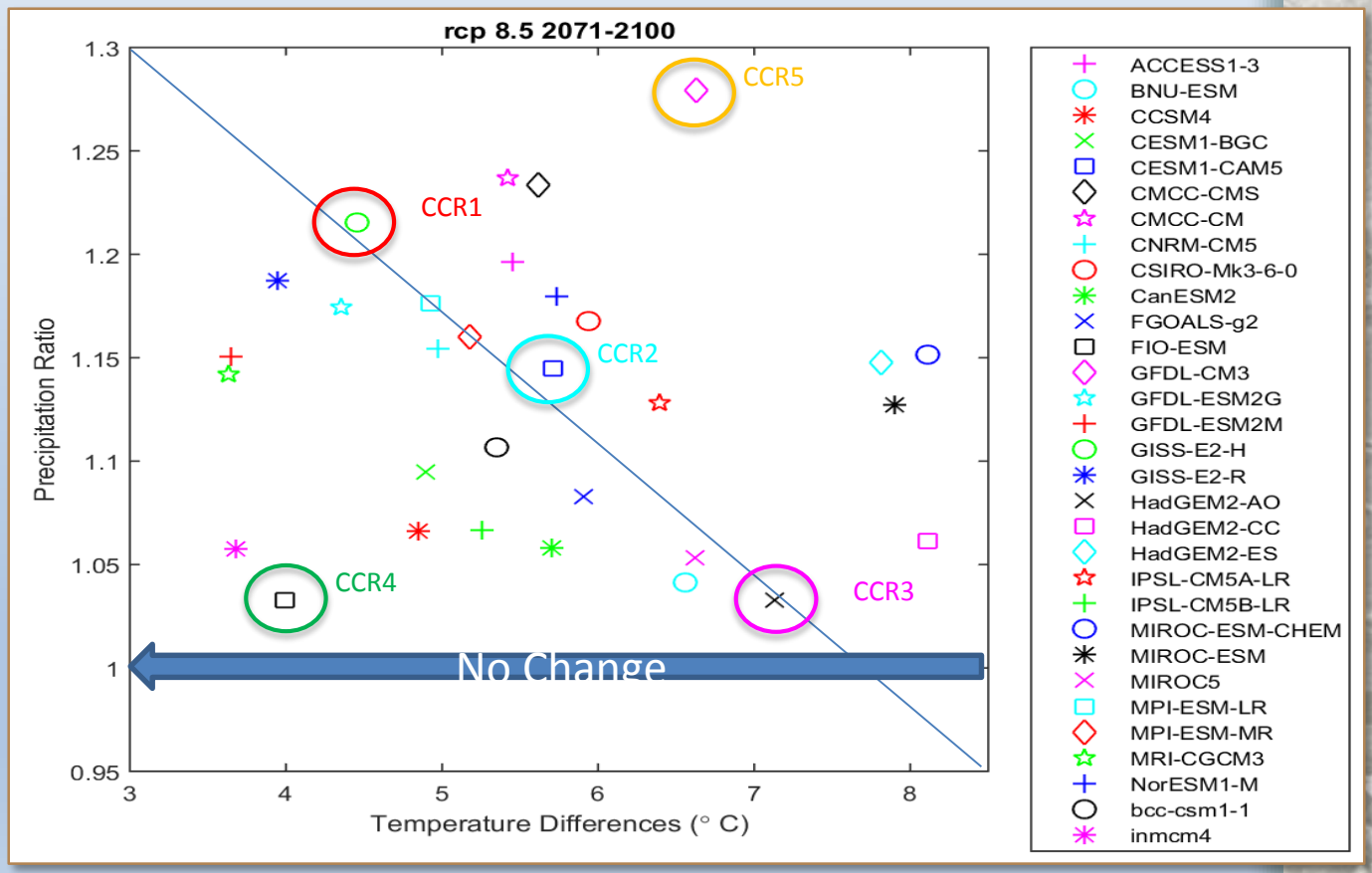
- Emission Scenarios: RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5
- Multiple General Climate Models (GMCs)
- Downscale to region of interest



Climate Change Simulation:

Climate Change

- Emission Scenarios = RCP 8.5
- Multiple General Climate Models (GMCs) = 31
- Downscale to region of interest (hybrid delta method)

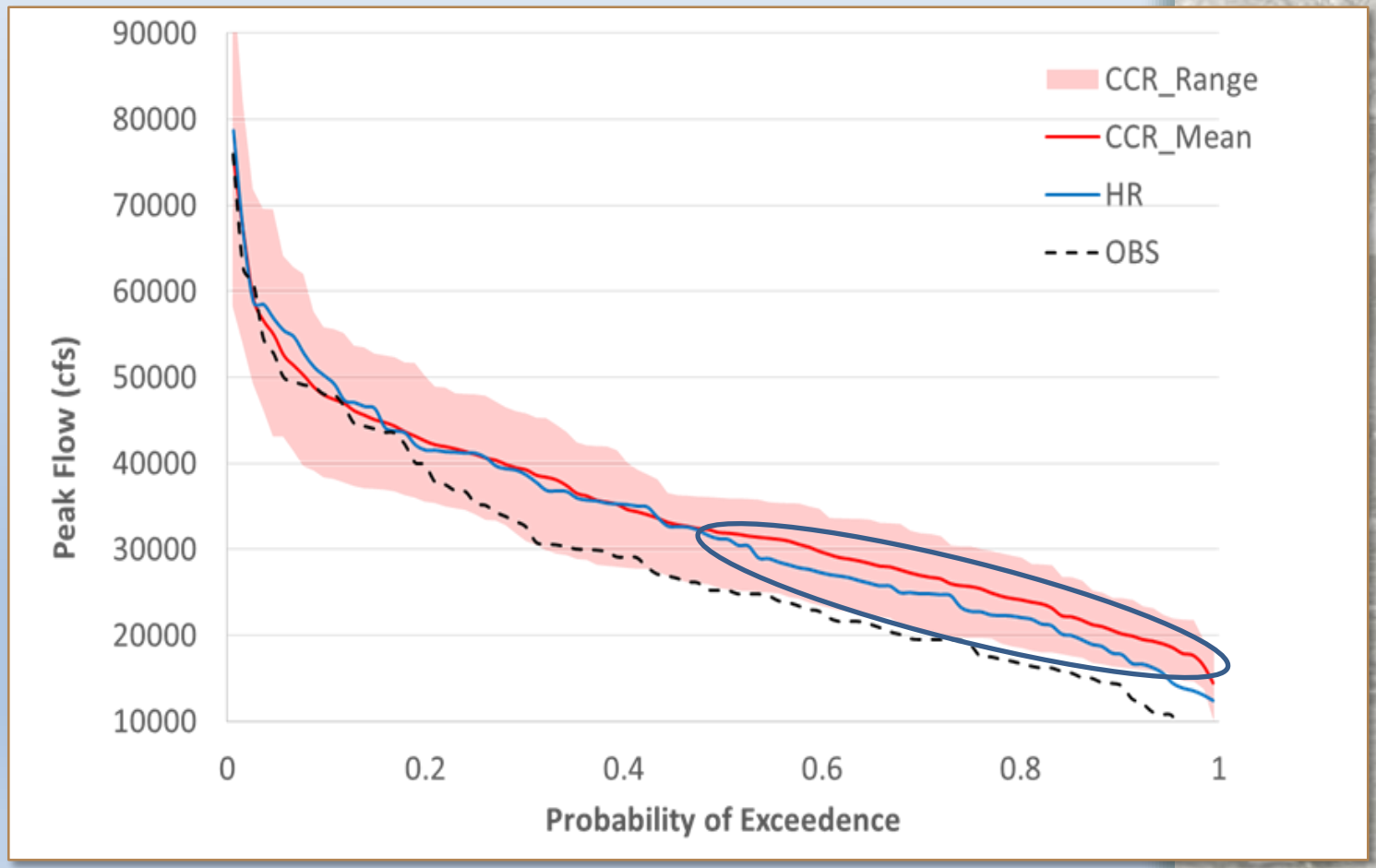


Byun K. and Hamlet A. F. Climate Change Projections for the Midwest Great Lakes Region Using Downscaled CMIP5 GCMs Ensembles (in preparation) http://www.crc.nd.edu/~kbyun/CMIP5_IN_CCIA.html

Projected Peak River Flows:

Climate Change

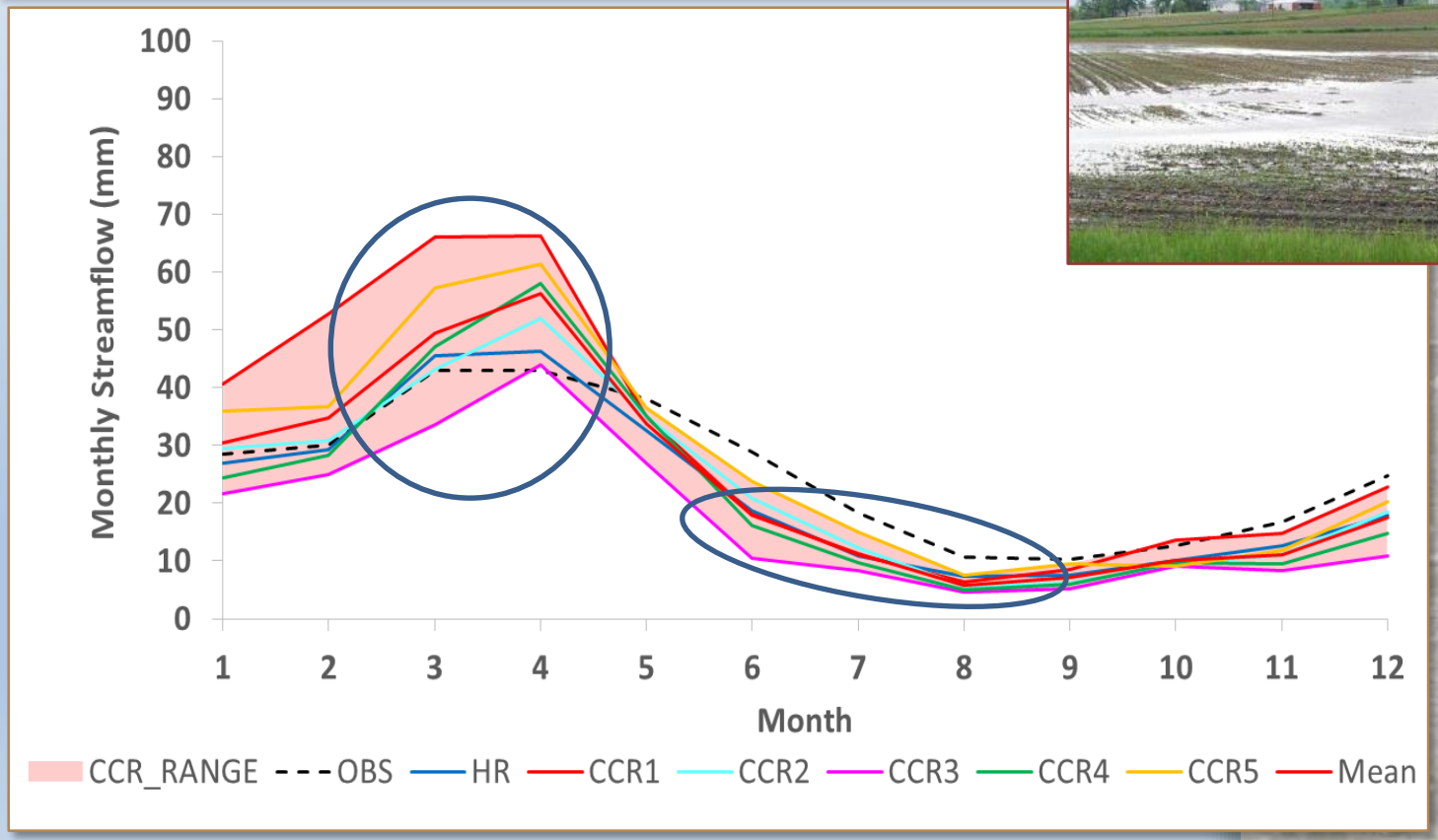
- Projected Period: 2020s
  - 20% increase in peak flow = more small floods



Seasonal Flows:

Climate Change

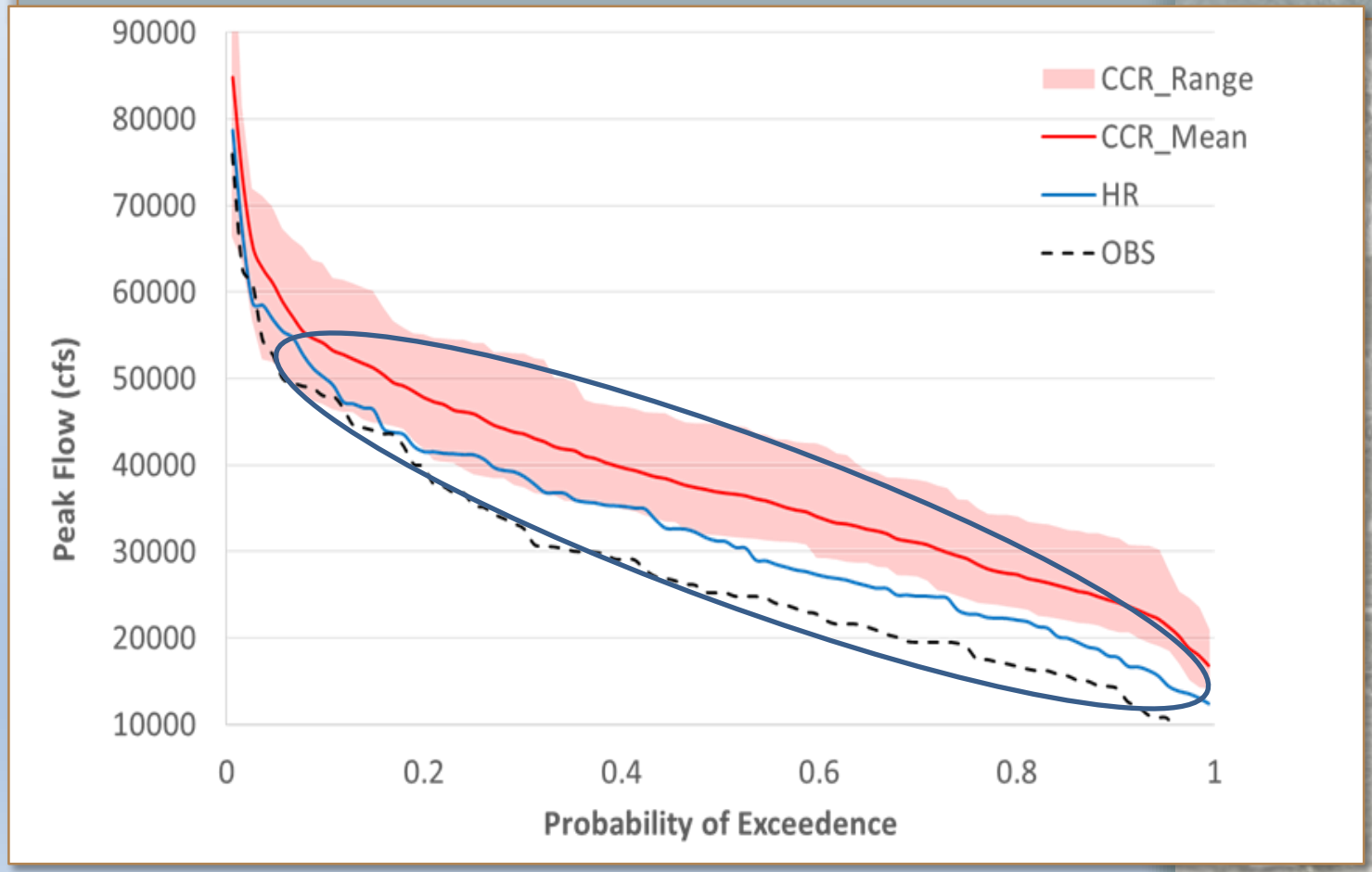
- Projected Period: 2020s
  - More springtime rain events
  - Heavy springtime rain events
  - Decrease in summer/fall rain events



Projected Peak River Flows:

Climate Change

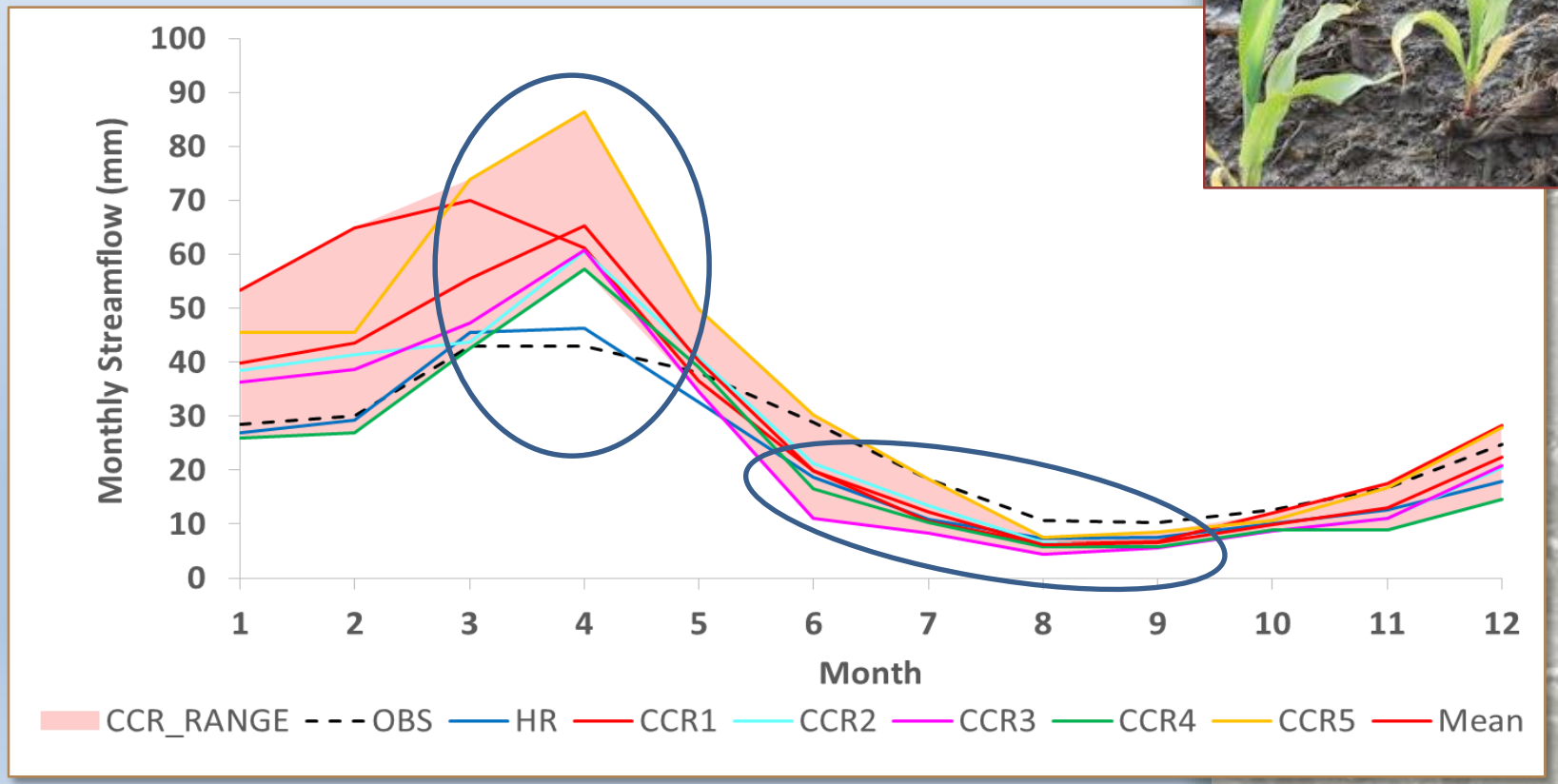
- Projected Period: 2050s
  - Increase in flooding
  - Annual flood = 40% increase



Seasonal Flows:

Climate Change

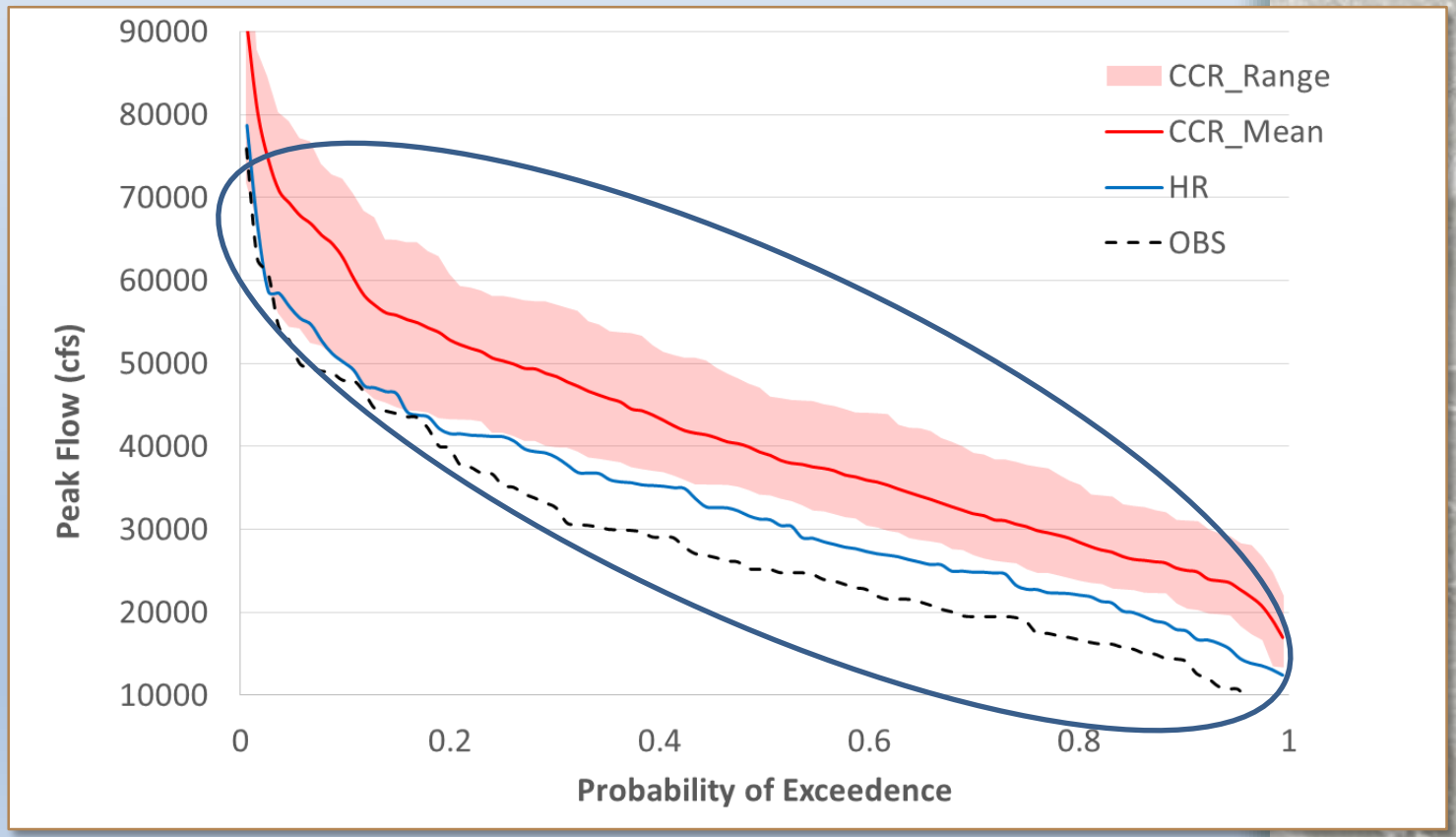
- Projected Period: 2050s
  - MORE spring rain events
  - HEAVIER springtime rain events
  - Decrease in summer/fall rain events



Projected Peak River Flows:

Climate Change

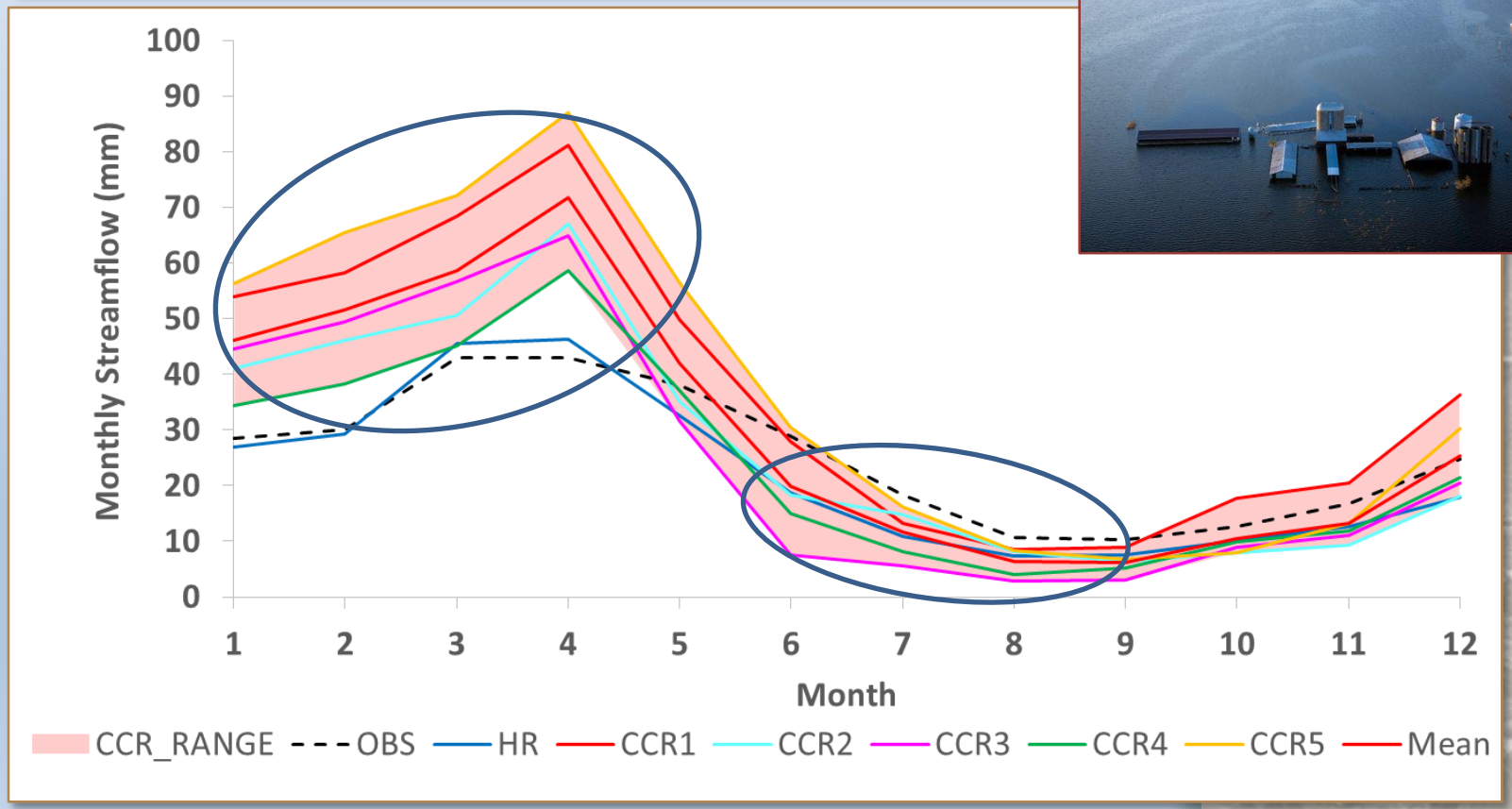
- Projected Period: 2080s
  - 50% increase in peak flows
  - LARGE Increase in flooding events



Seasonal Flows:

Climate Change

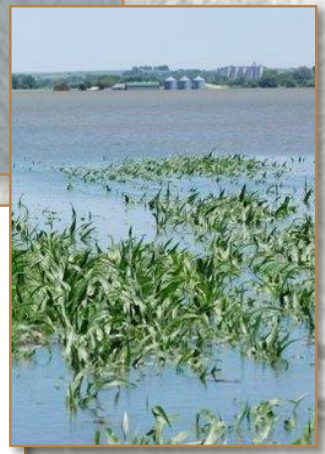
- Projected Period: 2080s
  - Doubling of springtime rain
  - WET, earlier winters
  - Dry summers

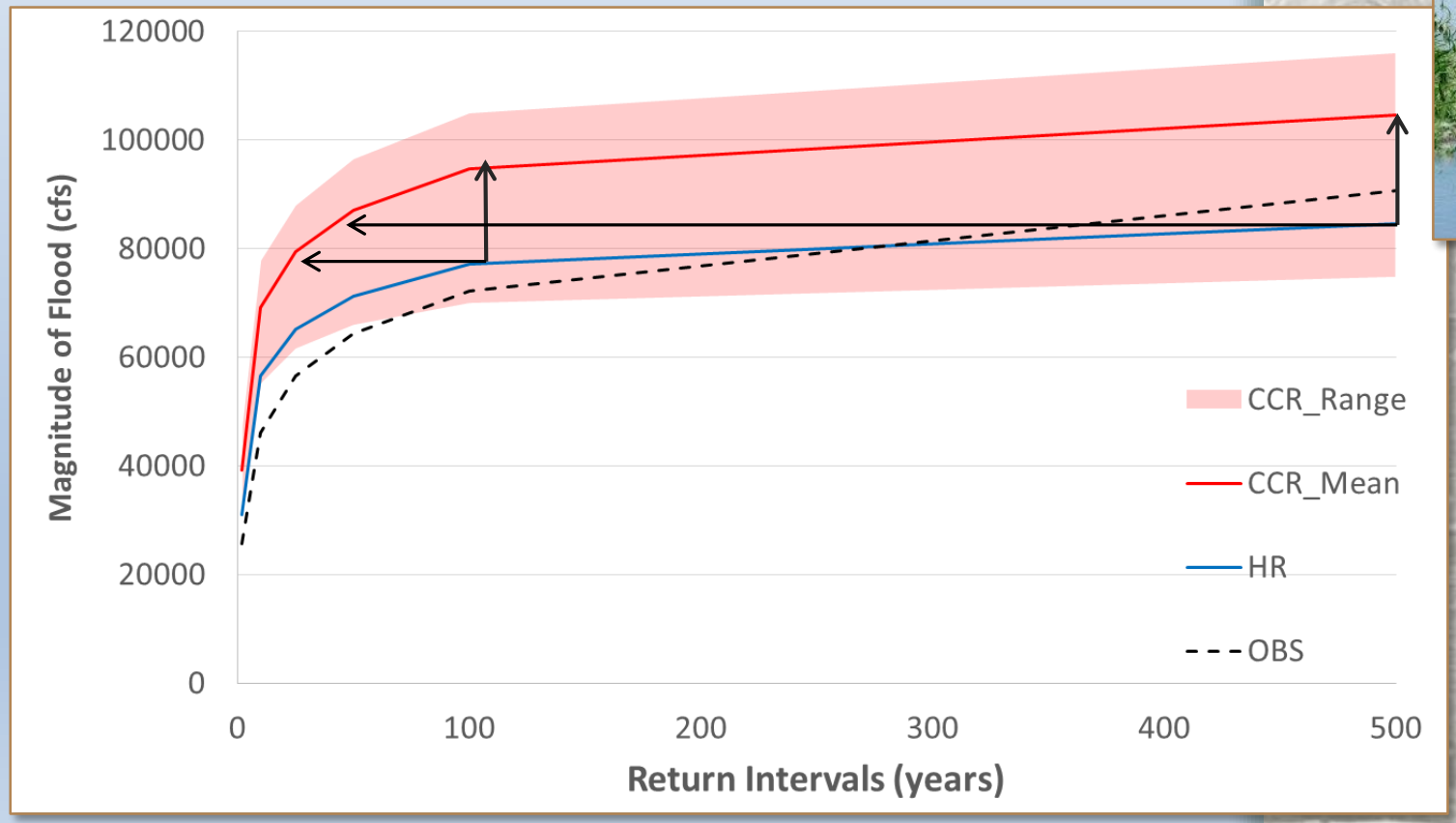


Projected Peak River Flows:

Climate Change

- Projected Period: 2080s
  - Present 100 yr flood = new 20 yr flood
  - Present 500 yr flood = new 50 yr flood
  - New 100 yr & 500 yr flood = 25% increase



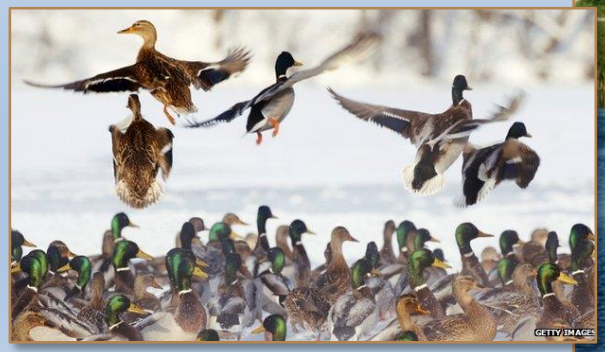


Wetland Restoration Scenarios

Peer Input → Land-use Scenarios

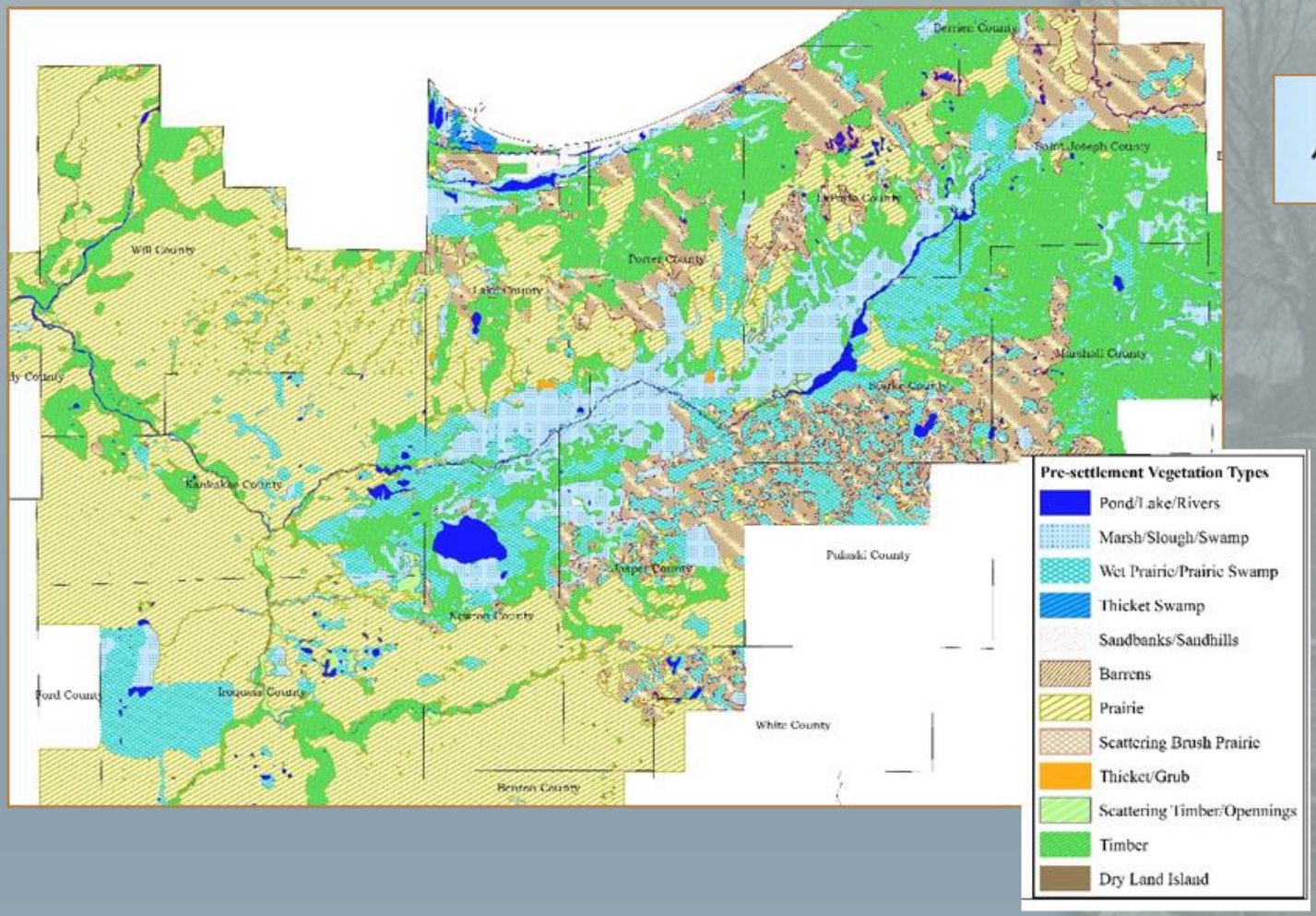
Peer-identified Scenarios

- Current landcover (no change)
- Historic Pre-settlement land cover
- Chicago Wilderness Green Infrastructure Vision (GIV)
- Upstream, non-prime farmland restoration (vs. riverside)
- Downstream, non-prime farmland restoration (vs. upstream)
  - Marginal and poor farmland
  - Frequently flooded farmland
  - Hydric soils



Historic Pre-Settlement Scenario

Land-use Scenarios



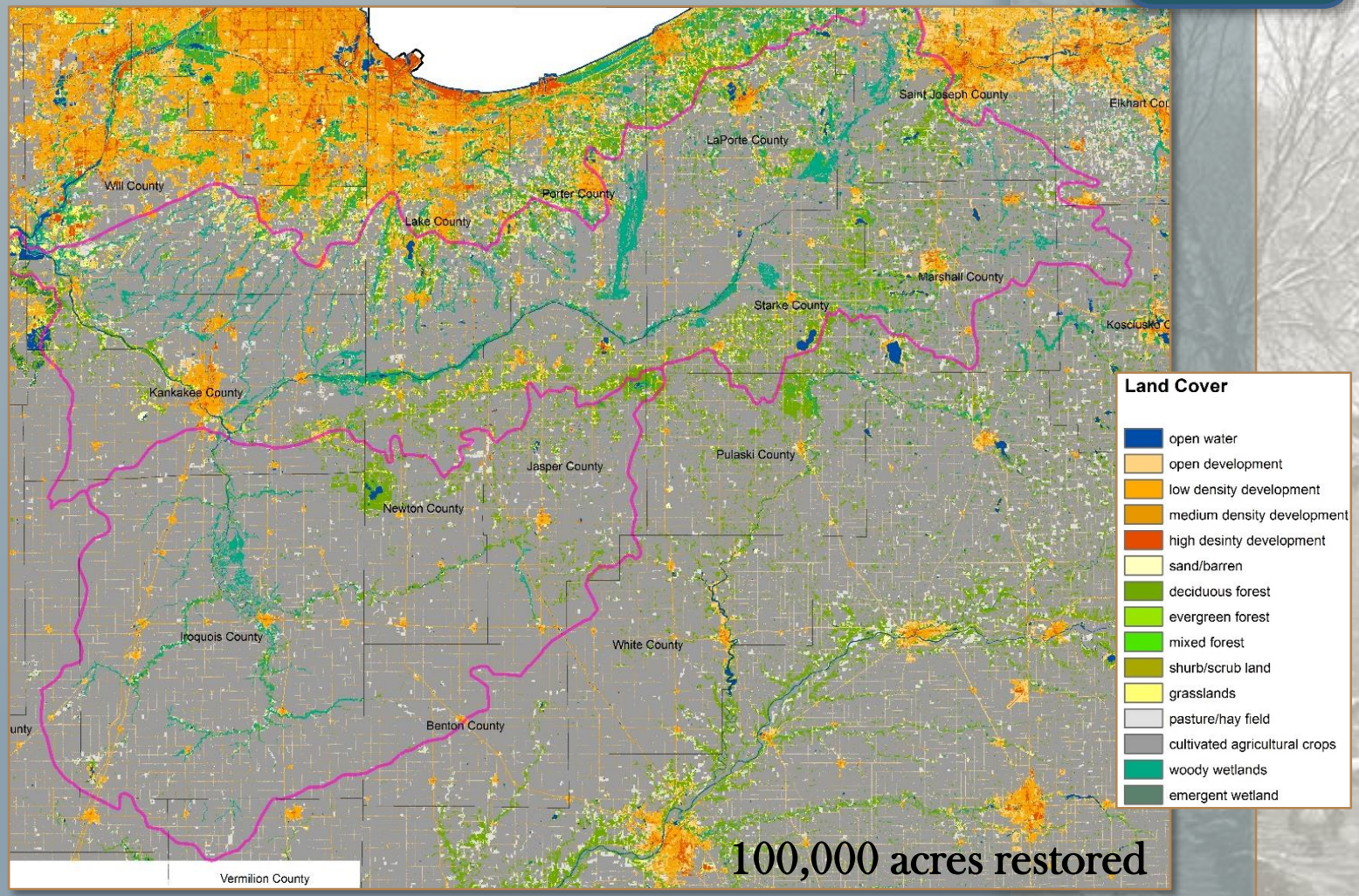
PaleON

Chicago Wilderness GIV Scenario

Land-use Scenarios

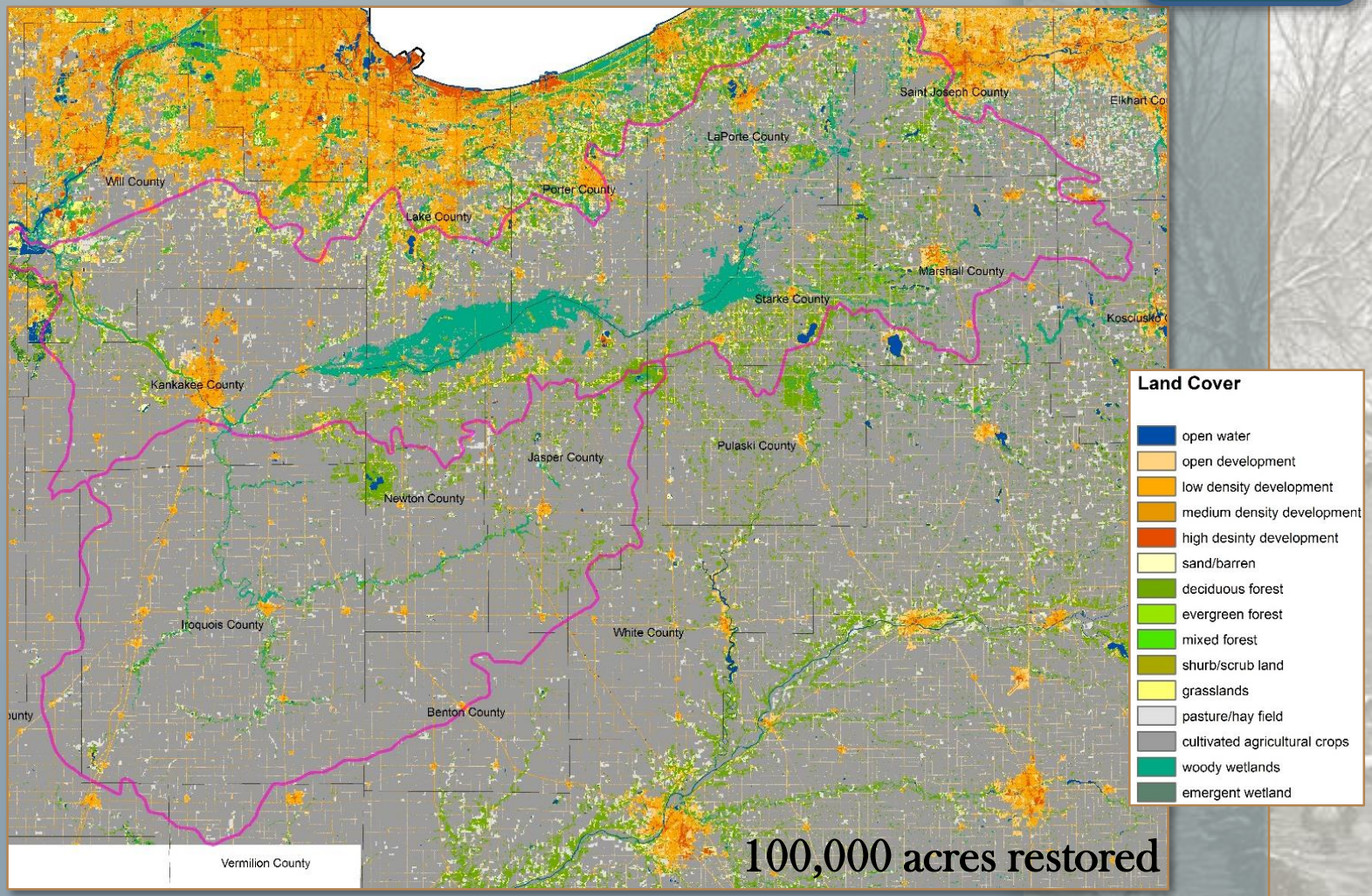
Upstream Non-prime Farmland Scenario

Land-use Scenarios



Downstream Non-prime Farmland Scenario

Land-use Scenarios



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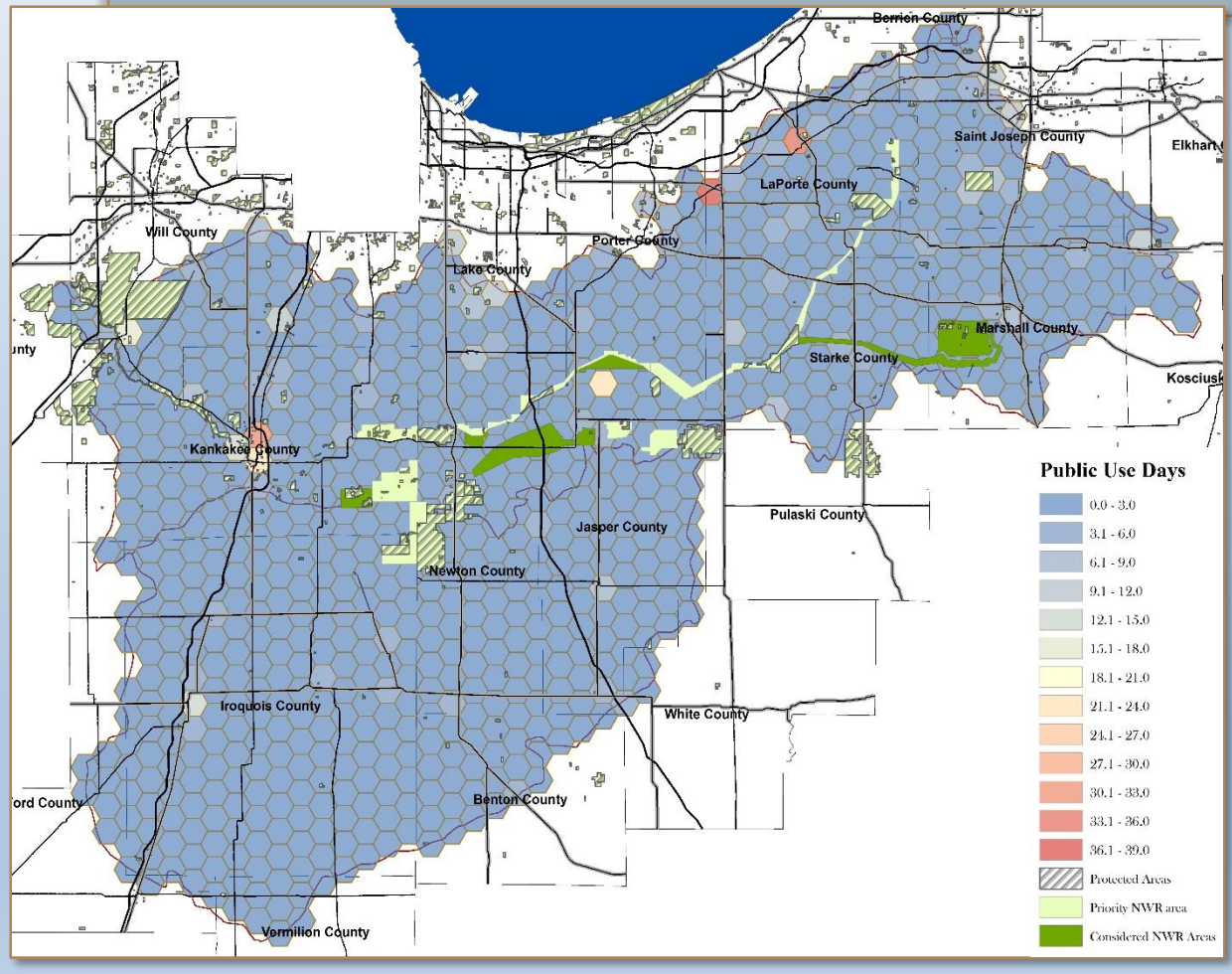
Recreational Ecosystem Service Value

Ecosystem Services

- Based on Natural Capital Project InVEST Recreational Model
  - Predictive Grid (below)



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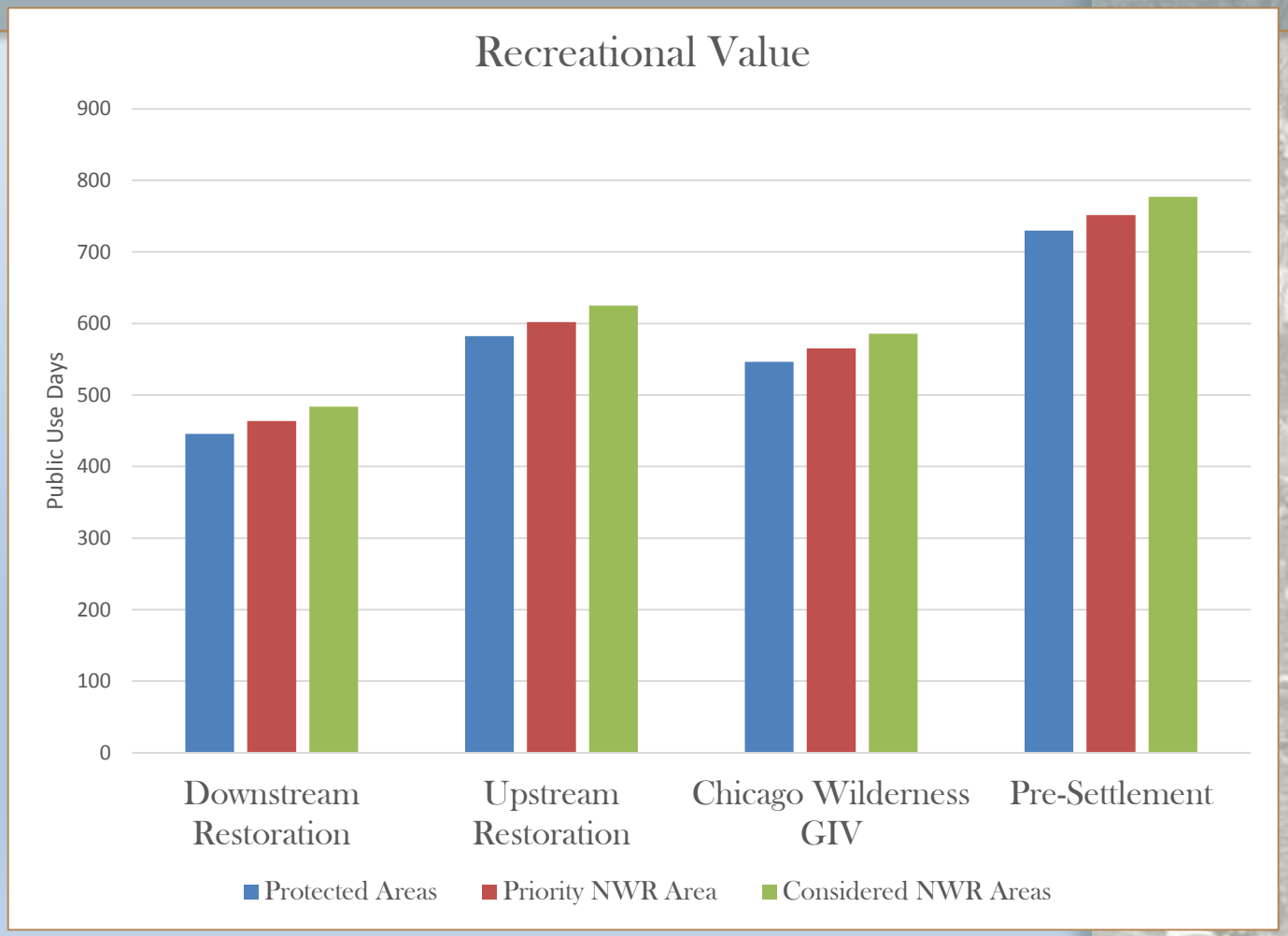
Recreational Value of Scenarios

Ecosystem Services

- Predictors = wetlands, developed & agricultural landcover, population, highways, naturalness, & protected areas



Conclusions

- Climate Change = higher temperature
- Climate Change in Kankakee = more water, but in large, severe SPRINGTIME rainfall events, & dryer, hotter summers
- Current Kankakee basin NOT designed for water retention, groundwater recharge, nor flood control
- Wetlands can provide water retention, help reduce flooding & improve water recharge to groundwater
- Conservation lands provide recreational value & opportunity

Tammy Patterson *tpatterson@usgs.gov*